A learning-by-project experience for motivating large engineering classes

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Abstract: - Newer approaches to teaching are being promoted by the onset of the Bologna Declaration. This paper describes the implementation of a methodology for promoting independent group work using tutorial techniques in the context of the Environmental Impact Assessment (EIA) course included in the undergraduate Civil Engineering programme at the University of Minho. The authors were faced with a multi-faceted problem: managing and motivating a large class of civil engineering students in a transdisciplinary and non-traditional civil engineering setting. Given the size of the class and the nature of the course, the authors decided to adopt, for the practical sessions, an approach based on semi-independent group work monitored via a series of scheduled progress meetings. At the end of the semester, the students were required to anonymously fill out a questionnaire regarding the class. The vast majority of the students felt that they were encouraged to express their points of view and in doing so, question the teacher in her own opinions and perceptions. Also, there was a general agreement that schedules were met according to what had been initially planned. An overwhelming majority felt there was concern and interest about the students, an observation supported by a general perception of encouragement, by the teacher, of their participating in the course's activities. When asked whether they would recommend the methodology implemented in the practical sessions to future students, the majority would do so, despite the great effort that would be required on their part. The freedom to manage their own work schedules was particularly appreciated, especially by students with heavier workloads from other courses. Also, the ability to conduct independent work was mentioned by some as an advantageous aspect of the course, particularly when given the chance to select topics more agreeable to their interests.

Key-Words: - Learning by project; Bologna Declaration; civil engineering; large classes; collaborative work.

1 Introduction

Newer approaches to teaching are being promoted by the onset of the Bologna Declaration. In its aim to deepen the understanding of higher education topics, it is fostering a series of transformations, namely in the way teachers are required to approach traditional and new materials and the manner in which students are expected to learn from them [1].

This renovation in methodologies is bringing about a shift in perception of roles and responsibilities of both teachers and students. Whereas teachers were once seen as the ultimate class manager, the students were seen as no more than pupils eager (or not) to learn the presented material.

Teachers were required to present the materials and evaluate the students over a written test of some sort. Depending on the subject's nature and constraints, a practical component would be added to the syllabus. The students would then have the opportunity to study, test and apply theoretical concepts, while possibly debating and discussing observations and results. Nevertheless, these practical sessions would still require a traditional managing approach from the instructor's standpoint and would not be considered more than a "practical lecture" of sorts.

Recent trends in education are providing the means for more inventiveness and flexibility in teaching, as well as some degree of "self-teaching" through collaborative learning [1, 2].

By allowing and requiring of the teacher to be more practical and creative in his or her approach, students must also recognise the necessity of more responsibility and discipline on their part.

The interactive lectures approach must improve a cooperative learning environment that encourages students to collaborate with their peers, questioning and teaching one another [3].

Certain subjects in large engineering classes have benefitted from this approach. In general, engineering students, though diverse in learning styles and apprenticeship, tend to favour more active approaches to learning [4], particularly those associated with

tutorial practices, rather than traditional lecture/teacher-driven presentations. This paper describes the implementation of a methodology for promoting independent group work using tutorial techniques in the context of the Environmental Impact Assessment (EIA) course included in the undergraduate Civil Engineering programme at the University of Minho.

2 Problem Formulation

Prior to the implementation of the Bologna Process, the EIA course was offered as an elective second-semester class to fifth-year students, which averaged a total of thirty individuals per school year for this course. Pursuant to the recommendations made by an external and international panel of evaluators and attuned to the on-going adaptation of curricula to the requirements of the Bologna Declaration, the course became a required subject for fourth-year undergraduates in the school year of 2007-2008. This meant an increase from 30 to approximately 150 students, and a necessary shift in teaching strategy, which was further complicated by the fact that the authors were called to re-design and manage a course that neither had taught before.

A carefully-organised and defined curriculum was critical to address the complexity and all-encompassing nature of the subject.

The authors decided to focus on concepts, laws and regulations, impact assessment processes and documental procedures within the Portuguese system for EIA and SEA (Strategic Environmental Assessment). This approach determined the course's aim, content, and teaching and evaluation methodologies.

The lecture sessions followed a more conventional technique, using overheads and multimedia presentations, through which the lecturer would present the learning topics, always supported by case studies for better conveying the complex issues under study.

The practical sessions were designed to handle the large number of students – divided into four different schedule sub-classes – and to address the fact that these could not be devoted to traditional numerical problem-solving exercises typical of the majority of the classes in the civil engineering programme. Because it would not rely on the application of calculations and/or design procedures, the authors had to find a way by which to motivate the students, since the topics covered in the course, though perceived as important, were often thought of as dull, tedious, frustrating and not able to meet the typical preferences of engineering students in favour of materials that lend themselves to more active, practical approaches to teaching and learning [4].

The authors were faced with a multi-faceted problem: managing and motivating a large class of civil engineering students in a transdisciplinary and non-traditional civil engineering setting.

3 Problem Solution

Given the size of the class and the nature of the course, the authors decided to adopt, for the practical sessions, an approach based on semi-independent group work monitored via a series of scheduled progress meetings.

3.1 Available Resources

Teachers are continuously looking for new and effective teaching resources, capable of fostering motivated and effective learning. The advent of new electronic educational tools has brought additional challenges that, nonetheless, present both teachers and students with numerous and valuable opportunities for improving the teaching and learning experience.

Having this in mind, the authors decided to use the institutional e-learning platform (*Blackboard Academic Suite*®, BAS), available at this University, in a variety of tasks such as sharing of class notes and study materials, and other tasks concerning class management (posting of notices, rules, etc.).

The students were able to access this platform to view and obtain posted materials and also to post their own work for evaluation.

The use of this technique for interfacing with the students proved to be an enhancement to the authors' teaching and evaluation strategy. For instance, the availability of a safe assignment tool offered by BAS platform allowed the teacher to verify plagiarism potential in the submitted reports. Aware of this functionality, students were *encouraged* to produce original text and carefully identify sources of information.

3.2 Course Organization

The course included two-hour long weekly lectures, for which attendance was strongly recommended but not mandatory.

These sessions were devoted to the presentation of the course's content as described in the previous section. There were also two-hour long weekly practical sessions, during which the students were asked to carry out practical work where they would

apply the theoretical concepts and methodologies presented in lecture. This would be done as a group project.

3.2.1 Practical sessions

Attendance was not taken during the practical sessions. Except for a few scheduled and mandatory progress meetings throughout the semester, the students were free to use the scheduled time and classroom to carry out the work however they saw fit. During these sessions, the teacher was available for answering any questions and providing guidance if requested. Exceptionally, the teacher presented a pre-scheduled class on a software tool that the groups were required to use.

3.2.2 Project assignment

Students were required to set up as groups of 3 to 5 elements for carrying out a series of tasks conducing to a final report to be submitted at the end of the semester for evaluation. Using file-databases publicly available in institutional websites and offices, each group was required to conduct a critical analysis of one or more cases concerning environmental impact assessment, in view of the concepts apprehended in lecture and through literature review of pertinent documents and applicable regulations.

There were concerns about providing thematic areas that would be adequately diverse and deterrent of work replication amongst the groups. In order to address this possibility, every group in each sub-class was asked to select and rank, by order of preference, three alternatives from a pre-defined list of thematic areas. Also, there were three different options as to the type of study to conduct. This ensured a varied distribution of thematic areas, though some were repeated between sub-classes. However, every group was able to select different real cases for studying.

3.2.3 Work monitoring

Progress monitoring was planned to assist the teacher in evaluating each group's performance throughout the semester.

Five progress meetings were scheduled at pre-determined dates and times – during the scheduled class time – with a single representative from each group (Fig. 1). This was a role that rotated among the team members and allowed the teacher to talk to each individual student at least once during the semester.

ENVIRONMENTAL IMPACT ASSESSMENT

PRACTICAL SESSIONS: Progress meetings

School year: 2007 - 2008

GROUP ID	THEME / TITLE	ELEMENTS		(Date 1)	(Date 2)	(Date 3)	(Date 4)	(Date 5)
		(ID Number)	(Full Name)					
1.1								
1.2								

Fig.1: Progress meetings schedule form

During the meetings, the group representative was responsible for presenting a short written and oral progress report (Fig. 2), answering any questions posed by the teacher.

ENVIRONMENTAL IMPACT ASSESSMENT

Practical Sessions: Group work monitoring

School year: 2007 - 2008

PROGRESS REPORT

Date:	Group:	Representative:
Title:		
Accomplished objectives:		**Goals for the next work period:**
(...)		(...)
Difficulties:		**Other issues:**
(...)		(...)

Fig.2: Progress report form

The report addressed objectives accomplished, goals and tasks to be performed, along with obstacles and difficulties felt within the group that were preventing a better performance. Other pertinent issues would also be addressed for which the students would seek the instructor's advice and guidance. Also, the teacher was available two-hours a week during office hours, for additional guidance to the groups that requested it. With regards to more trivial matters, quick e-mail "consults" were offered as well.

3.2.4 Self and peer-assessment

At the end of the semester and upon submitting the written report, each student was required to conduct a simple exercise of self and peer-assessment.

Each group element was asked to send, in a private e-mail, an evaluation of his/her and peer contribution (in percentage) to the total group effort.

This was useful in determining the individual performance within the group, as work distribution is not always uniform and equitable.

The goal was to assist the teacher in grading the elements in a group and to assign different individual scores, if warranted.

4 Results and Discussion

Of the 149 students enrolled in the course, 132 formed 31 groups. By the end of the semester, a total of 26 reports were handed in for evaluation, corresponding to a total of 109 students or a level of completion of approximately 83% (Fig. 3).

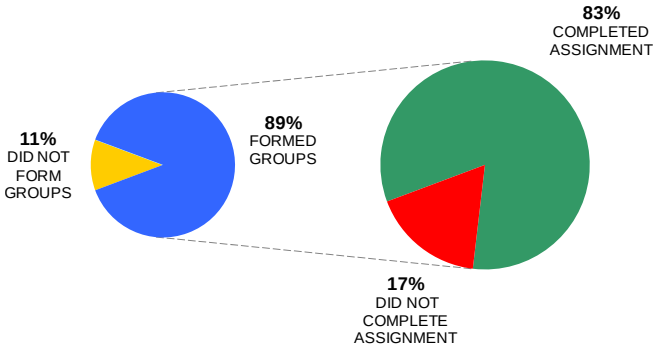

Fig.3: Student participation levels

Overall, the students actively participated in course's activities, generally demonstrating a satisfactory ability to carry out the tasks assigned, with varied levels of enthusiasm and commitment to the project.

At the end of the semester, each student was given the opportunity to fill out an anonymous questionnaire as part of the school's Teaching/Learning Evaluation survey. The instructors were also required to complete a similar form. In this survey, both parties were required to rate, on a 6-point scale – 1 for "Strongly Disagree" through 6, for "Strongly Agree" – the quality of teaching and learning (lecture and practical) offered in terms of 37 parameters, including a self-assessment part. The results of this survey are encouraging and agree with information derived from casual conversations with random students throughout the semester.

The global evaluation of the course (Fig. 4) obtained an average grade of 3.20 out of possible 6, practically par with the perception of the importance of the course, which obtained an average score of 3.24.

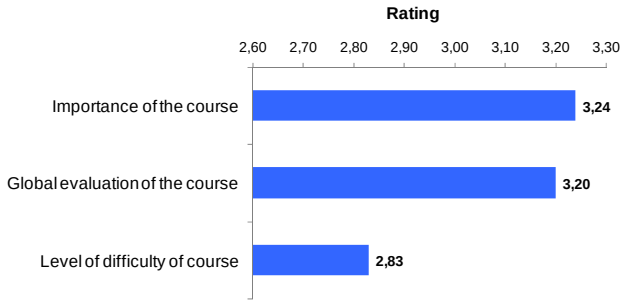

Fig.4: Least-rated parameters

The responses were practically split between the students, with a slightly higher fraction of agreeing rather than disagreeing students (51 to 55 over 45 to 49%, respectively). In terms of the least rated parameters, the majority (72%) of the students found the course to be challenging and difficult, a perception that mirrors the initial concerns of the authors.

This assessment was supported by feelings of anxiety regarding the lecture-part of the course. As it was, the final grade of the course resulted from a weighted average of the practical grade (worth 35%) and the theoretical grade, in the form of two written-tests administered during the semester at previously defined dates. The written evaluation tests were designed to appraise the theoretical knowledge derived from the lecture classes and carried a global weight of 65% of the final grade.

When asked about the lecture classes, the students themselves admitted a lack of enthusiasm for the materials and learning topics. These observations were supported by feelings of "bewilderment" and incomprehension about the way the course was being managed this year, when "…it had been so differently done in the past".

When the rationale for the new approach was explained, the students understood it and accepted it but had a difficult time letting go of their pre-conceived notions regarding how demanding they thought it would be, fostered by conversations with older classmates that had successfully taken the course in previous years. Because they were based on the courses' historical record, these perceptions proved difficult to overcome emotionally, though intellectually, it was clear to the students that they should not have expected different teachers (past and present) to have the same approaches, particularly when the context of the course had changed, as dramatically as it had.

As anticipated, the students were none too thrilled nor thrilling with their performance in the written tests. These feelings of frustration and apprehension compounded by a fear of failing the class altogether (even before the written test grades were known) overflowed into the practical sessions, hindering the groups motivation to go on working and finish the job they had set out to complete.

The scheduled progress meetings often became encouragement and pep talk sessions, in order to keep the students focused and motivated. Most groups persevered and managed to stay committed to the tasks at hand.

The results are illustrated in Figure 5 correspond to the better-rated parameters in the survey.

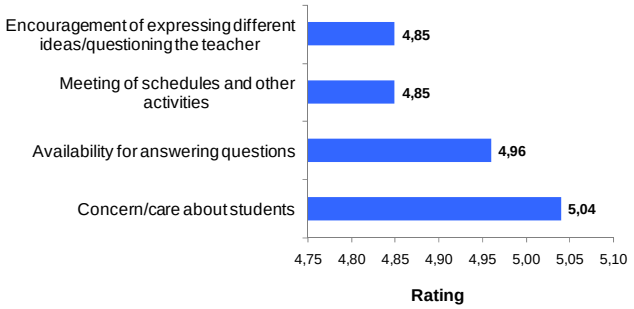

Fig.5: Most-rated parameters

The vast majority of the students (94%) felt that they were encouraged to express their points of view and in doing so, question the teacher in her own opinions and perceptions. Also, there was a general agreement that schedules were met according to what had been initially planned. An overwhelming majority (98%) felt there was concern and interest about the students, an observation supported by a general perception of encouragement, by the teacher, of their participating in the course's activities (rated 4.71, not shown).

5 Conclusions

The freedom to manage their own work schedules was particularly appreciated, especially by students with heavier workloads from other courses. Also, the ability to conduct independent work was mentioned by some as an advantageous aspect of the course, particularly when given the chance to select topics more agreeable to their interests.

There was a general sense of acknowledgement of increased need for more individual discipline and effort to remain committed to the work, since the groups were entirely responsible for managing schedules, assigning tasks and getting the job done. Most students were able to effectively meet these responsibilities.

The exposure of students to real situations encouraged the search for additional material deemed relevant for the tasks at hand. In fact, by accessing a list of recommend institutional websites, all students had access to documentation pertaining to complete EIA processes as mandated by Portuguese Law, regulations and guidelines, allowing them a broader understanding of the field study in a "real-world" context. Also, by promoting the critical review of real cases, students were given the opportunity to observe and discuss some aspects of bringing theory (regulations and guidelines) to practice (real evaluation processes).

The purpose of the peer and self-assessment exercise was understood by all as an important, though not necessarily, essential task.

Nevertheless, all students complied and turned in their assessments as required. The majority of the individual reports agreed in their effort distribution and not surprisingly, the majority of the students assigned equal effort percentages to themselves and their group peers. Though not exactly corresponding to the truth – to the best of the teacher's knowledge derived from observation throughout the semester – the decision to assign equal work loads demonstrated a sense of team unity. However, there were two separate instances that required the mediation of the teachers, since the students within the two groups involved would not agree on how the work had been carried out. These occurrences point out to the need for additional reflexion with regards to including self and peer-assessment as a requirement in future group projects.

Another advantageous aspect of the methodology was that evaluating the written reports was positively supported by the regular student and teacher interaction during the progress meetings, weekly office hours and via e-mail, which kept the teacher informed and updated about the on-going work. Having previous knowledge of each project's history and group performance definitely aided in the final reading and evaluation.

As implemented, this methodology required different levels of effort from the teacher throughout the semester, with moments of more intensity at the beginning and at the end. Since these higher intensity moments were planned from the start, the more open schedule during the semester was refreshing and welcome, allowing the teacher to focus on other areas of activity, namely other courses and research.

When asked whether they would recommend, to future school-year students, the methodology implemented in the practical sessions, the majority of the students would do so, despite the great effort that would be required. However, it was acknowledged that future students would benefit from this class' experiences and admonitions, in what would be a clear advantage over the 2007-2008 students. Accordingly, the authors are in the process of implementing similar methodologies in courses already underway in the 2008-2009 school-year.

The experience described herein represents a significant move towards further and renewed approaches to managing large classes of engineering students in a transdisciplinary context. More than addressing motivational concerns, it provided students with a stepping-stone for acquiring and enhancing individual skills to enable a more complete development of their personal and professional identities.

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